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(71) Applicant:

MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.
Kadoma-shi, Osaka 571-8501 (JP)

(72) Inventors:

- YAMAGUCHI, Manabu
Yokohama-shi, Kanagawa 233-0008 (JP)
- OBARA, Toshio
Kawasaki-shi, Kanagawa 212-0025 (JP)

(74) Representative:

Grünecker, Kinkeldey,
Stockmair & Schwanhäusser
Anwaltssozietät
Maximilianstrasse 58
80538 München (DE)

(54) RADIO DEVICE AND TRANSMITTING/RECEIVING METHOD

(57) At the time of ordinary communication, up-mixer 108 combines a signal with a frequency 22 from frequency synthesizer 124 with I and Q signals for transmission that are quadrature modulated in quadrature modulator 105, down-mixer 115 combines the signal with the frequency f2 with a received signal, then only in the case of receiving a signal with a frequency f'r different from a frequency fr, frequency synthesizer 125 that generates a signal with a frequency f3 different from the frequency f2 is operated, and frequency synthesizer

125 and down-mixer 115 are connected with switch 127, so that down-mixer 115 combines the signal with the frequency f3 with a received signal. It is thereby possible to switch frequencies fast and with low current consumption in receiving a signal with a reception frequency other than a combination of transmission frequency and reception frequency specified in an ordinary radio system.

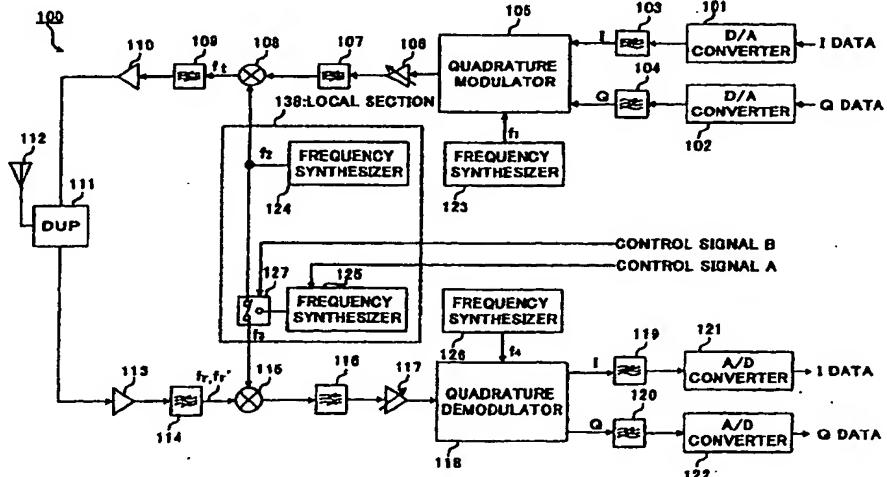


FIG.2

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Description**Technical Field**

[0001] The present invention relates to a radio apparatus used in a digital mobile communication system and the like, and more particularly, to a radio apparatus and transmission/reception method used in a CDMA (Code Division Multiple Access) mobile communication system.

Background Art

[0002] FIG.1 is a block diagram illustrating a configuration of a conventional radio apparatus. The conventional radio apparatus illustrated in FIG.1 is used in a radio system such that a reception frequency is only switched to another frequency at the time a transmission signal is transmitted so as to obtain a level measurement on a reception frequency channel that is different from an ordinary transmission/reception frequency combination and further obtain system control information.

[0003] Radio apparatus 10 is provided with D/A converters 11 and 12 to which I channel data and Q channel data (hereinafter, respectively referred to as I data and Q data) is respectively input, low-pass filters 13 and 14, quadrature modulator 15, gain control amplifier 16, band-pass filter 17, up-mixer 18, band-pass filter 19, and power amplifier 20. Radio apparatus 10 is further provided with antenna duplexer 21 and antenna 22. Radio apparatus 10 is furthermore provided with low noise amplifier 23, band-pass filter 24, down-mixer 25, band-pass filter 26, gain control amplifier 27, quadrature demodulator 28, low-pass filters 29 and 30, and A/D converters 31 and 32 that respectively output I data and Q data. Still furthermore, radio apparatus 10 is provided with transmission IF (intermediate) frequency synthesizer 33, transmission RF (radio) frequency synthesizer 34, reception RF frequency synthesizer 35, and reception IF synthesizer 36.

[0004] The next explanation is given of the transmission processing operation in radio apparatus 10.

[0005] I data and Q data to be transmitted is converted into respective analog signals in D/A converters 11 and 12, subjected to low-pass filtering in low-pass filters 13 and 14, and then converted in quadrature modulator 15 into a signal with a transmission IF frequency using a signal generated from transmission IF frequency synthesizer 33, respectively.

[0006] The converted signal with the transmission IF frequency is amplified in gain control amplifier 16 corresponding to a control voltage, filtered in band-pass filter 17 to pass a signal with a predetermined frequency band, and then converted in up-mixer 18 into a signal with a transmission RF frequency using a signal generated from transmission RF frequency synthesizer 34.

[0007] The converted signal with the transmission

RF frequency is filtered in band-pass filter 19 to pass a signal with a predetermined frequency band, amplified in power amplifier 20, and output to antenna duplexer 21 that separates a transmission frequency signal and reception frequency signal, whereby the radio signal is transmitted from antenna 22.

[0008] The next explanation is given of the reception processing operation in radio apparatus 10.

[0009] A quadrature modulated signal with a reception frequency received at antenna 22 is output to antenna duplexer 21 which separates a transmission frequency signal and reception frequency signal. The resultant signal is subjected to low noise amplification in low noise amplifier 23, filtered in band-pass filter 24 to pass a signal with a predetermined frequency band, and then converted in down-mixer 25 into a signal with a reception IF frequency using a signal generated from reception RF frequency synthesizer 35.

[0010] The converted signal with the reception IF frequency is filtered in band-pass filter 26 to pass a signal with a predetermined frequency band, amplified in gain control amplifier 27 corresponding to a control voltage, subjected to quadrature demodulation in quadrature demodulator 28 using a signal generated in reception IF frequency synthesizer 36, and then demodulated to an I signal and Q signal.

[0011] The I signal and Q signal are subjected to low-pass filtering in low-pass filters 29 and 30, and converted into respective digital signals in A/D converters 31 and 32, respectively, whereby I data and Q data are output.

[0012] It is herein assumed that a transmission RF frequency is f_t , a reception RF frequency is f_r , and that the f_t and f_r have a relationship of $f_r > f_t$. the transmission RF frequency and reception RF frequency are specified so that f_r minus f_t ($f_r - f_t$) is constant.

[0013] Accordingly, assuming that a frequency of transmission IF frequency synthesizer 33 is f_1 , a frequency of transmission RF synthesizer 34 is f_2 , a frequency of reception RF synthesizer 35 is f_3 , and that a frequency of reception IF frequency synthesizer 36 is f_4 , the transmission RF frequency f_t is expressed with $f_2 - f_1$ or $f_2 + f_1$, the reception RF frequency f_r is expressed with $f_3 - f_4$ or $f_3 + f_4$, and f_2 equals f_3 ($f_2 = f_3$) at the time of the ordinary operation where $f_r - f_t$ is constant.

[0014] When a signal is received which has a reception RF frequency f_r where $f_r - f_t$ is not constant, i.e., when $f_2 > f_3$ or $f_2 < f_3$, the frequency of reception RF synthesizer 35 is switched corresponding to the reception frequency f_r that is different from f_r . In this case, a quadrature modulated signal with the reception frequency f_r received at antenna 22 is output to antenna duplexer 21 while being separated from a signal with the transmission frequency, subjected to low noise amplification in low noise amplifier 23, filtered in band-pass filter 24 to pass a signal with a predetermined frequency band, and subjected to frequency conversion in down-mixer 25 using a signal with a frequency generated in

reception RF frequency synthesizer 35 corresponding to the reception frequency f_r' so that the reception frequency is the same as a case that the reception IF frequency is f_r .

[0015] In the above-mentioned conventional apparatus, however, when a signal is received which has a frequency different from usually specified one in a communication, it is necessary to fast switch a frequency of reception RF frequency synthesizer 35, and further to concurrently operate reception RF frequency synthesizer 35 and transmission RF frequency synthesizer 34, thereby resulting in a problem that current consumption becomes great.

Disclosure of Invention

[0016] It is an object of the present invention to provide a radio apparatus and transmission/reception method capable of performing frequency switching fast and with low current consumption in the case of receiving a signal with a frequency different from ordinary specified one.

[0017] This object is achieved by generating in a common frequency synthesizer a first frequency signal with a transmission frequency and reception frequency combined, generating in a reception frequency synthesizer a second frequency signal with a frequency different from that of the first frequency signal, combining in a transmission mixer the first frequency signal and quadrature modulated transmission I and Q signals, and at the time of ordinary communications, combining in a reception mixer the first frequency signal and a received signal, while only at the time of receiving a signal with a frequency different from the first frequency, operating the reception frequency synthesizer to combine the received signal with the second frequency signal.

Brief Description of Drawings

[0018]

FIG.1 is a block diagram illustrating a configuration of a conventional radio apparatus;
 FIG.2 is a block diagram illustrating a configuration of a radio apparatus according to a first embodiment of the present invention;
 FIG.3 is a block diagram illustrating a configuration of a radio apparatus according to a second embodiment of the present invention;
 FIG.4 is a block diagram illustrating a configuration of a radio apparatus according to a third embodiment of the present invention;
 FIG.5 is a block diagram illustrating a configuration of a radio apparatus according to a fourth embodiment of the present invention;
 FIG.6 is a block diagram illustrating a second configuration of a radio apparatus according to the

fourth embodiment of the present invention; and
 FIG.7 is a block diagram illustrating a third configuration of a radio apparatus according to the fourth embodiment of the present invention.

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[0019] Embodiments of the present invention are explained below with reference to accompanying drawings.

(First embodiment)

[0020] FIG.2 is a block diagram illustrating a configuration of a radio apparatus according to the first embodiment of the present invention. Radio apparatus 100 illustrated in FIG.2 is used for a mobile station apparatus and the like in a digital mobile communication system.

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[0021] Radio apparatus 100 is provided with D/A converters 101 and 102 to which I data and Q data is input respectively, low-pass filters 103 and 104, quadrature modulator 105, gain control amplifier 106, band-pass filter 107, up-mixer 108, band-pass filter 109, and power amplifier 110. Radio apparatus 100 is further provided with antenna duplexer 111 and antenna 112. Radio apparatus 100 is furthermore provided with low noise amplifier 113, band-pass filter 114, down-mixer 115, band-pass filter 116, gain control amplifier 117, quadrature demodulator 118, low-pass filters 119 and 120, and A/D converters 121 and 122. Still furthermore, radio apparatus 100 is provided with transmission IF frequency synthesizer 123, transmission RF frequency synthesizer 124, reception RF frequency synthesizer 125, reception IF frequency synthesizer 126, and switch 127.

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[0022] Moreover, a local section 138 is comprised of transmission RF frequency synthesizer 124, reception RF frequency synthesizer 125 and switch 127. A control signal A is provided to reception RF frequency synthesizer 125, and a control signal B is provided to switch 127.

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[0023] It is assumed in the following explanation that a transmission RF frequency is f_t , a reception RF frequency is f_r , a frequency of transmission IF frequency synthesizer 123 is f_1 , a frequency of transmission RF frequency synthesizer 124 is f_2 , a frequency of reception RF frequency synthesizer 125 is f_3 , a frequency of reception IF frequency synthesizer 126 is f_4 , f_r is larger than f_t ($f_r > f_t$), the reception RF frequency f_r equals f_3 minus f_4 ($f_r = f_3 - f_4$), the transmission RF frequency f_t equals f_2 minus f_1 ($f_t = f_2 - f_1$) that is an upper (upper limit side) local frequency structure, and a reception RF frequency f_r' that is different from the frequency at the time of ordinary communication equals f_3 minus f_4 ($f_r' = f_3 - f_4$) that is a lower (lower limit side) local frequency structure. In addition, the upper and lower are reversible.

[0024] The following explanation is given of the transmission processing operation in radio apparatus 100 at the time of the ordinary communication where $f_r - f_t$ is constant. I data and Q data to be transmitted is converted into analog signals in D/A converters 101 and 102, subjected to low-pass filtering in low-pass filters 103 and 104, and then converted in quadrature modulator 105 into a signal with the transmission IF frequency f_1 using a signal with the frequency f_1 generated in transmission IF frequency synthesizer 133, respectively.

[0025] The converted signal with the transmission IF frequency is amplified in gain control amplifier 106 corresponding to a control voltage, filtered in band-pass filter 107 to pass a signal with a predetermined frequency band, and then converted in up-mixer 108 into a signal with the transmission RF frequency ($f_t = f_2 - f_1$) using a signal with the frequency f_2 generated in transmission RF frequency synthesizer 124.

[0026] The converted signal with the transmission RF frequency is filtered in band-pass filter 109 to pass a signal with a predetermined frequency band, and amplified in power amplifier 110, and output to antenna duplexer 111 that separates a transmission frequency signal and reception frequency signal, whereby the radio signal is transmitted from antenna 112.

[0027] The explanation is next given of the reception processing operation in radio apparatus 100 at the time of the ordinary communication where $f_r - f_t$ ($f_r - f_t$) is constant. At this point, switch 127 connects reception RF frequency synthesizer 124 and down-mixer 115 according to the control signal B, and reception RF frequency synthesizer 125 is turned off with the control signal A.

[0028] A quadrature modulated signal received at antenna 112 is output to antenna duplexer 111 which separates the transmission frequency signal and reception frequency signal. The resultant signal is subjected to low noise amplification in low noise amplifier 113, filtered in band-pass filter 114 to pass a signal with a predetermined frequency band, and then converted in down-mixer 115 into a signal with the reception IF frequency f_4 ($f_4 = f_2 - f_r$) using a signal with the frequency f_2 generated in transmission RF frequency synthesizer 124.

[0029] The converted signal with the reception IF frequency f_4 is filtered in band-pass filter 116 to pass a signal with a predetermined frequency band, amplified in gain control amplifier 117 corresponding to a control voltage, subjected to quadrature demodulation in quadrature demodulator 118 using a signal with the frequency f_4 generated in reception IF frequency synthesizer 126, and thereby demodulated to an I signal and Q signal.

[0030] The I and Q signals are subjected to low-pass filtering in low-pass filters 119 and 120, and converted into respective digital signals in A/D converters 121 and 122, respectively, whereby I data and Q data is

output.

[0031] The explanation is next given of the operation of local section 138 when the apparatus receives a signal with the reception frequency f_r' such that $f_r - f_t$ ($f_r - f_t$) is not constant, while transmitting a signal with the transmission RF frequency f_t .

[0032] Transmission RF frequency synthesizer 124 in Local section 138 outputs a signal with the transmission RF frequency f_t such that $f_r - f_t$ is constant using a signal with the frequency f_2 .

[0033] Reception RF frequency synthesizer 125 is turned on with the control signal A, and generates a signal with the frequency f_3 such that $f_3 - f_r'$ equals f_4 ($f_4 = f_3 - f_r'$). Switch 127 is controlled with the control signal B in synchronism with a timing at which a reception is started so as to connect reception RF frequency synthesizer 125 and down-mixer 115.

[0034] Down-mixer 115 multiplies an output signal from band-pass filter 114 by a signal with the frequency f_4 generated in reception RF frequency synthesizer 125.

[0035] Thus, when the ordinary communication is performed, a signal generated in transmission RF frequency synthesizer 124 is output to up-mixer 108, while being output to down-mixer 115 through switch 127. Then, only in the case of receiving a signal with a frequency different from that in the ordinary communication, reception RF frequency synthesizer 125 is operated, and reception RF frequency synthesizer 125 and down-mixer 115 are connected by switch 127. According to the foregoing, since it is only required to operate a single RF frequency synthesizer at the time of the ordinary communication, it is possible to reduce the current consumption as compared to the conventional case that requires two RF frequency synthesizers to be operated.

(Second embodiment)

[0036] FIG.3 is a block diagram illustrating a configuration of a radio apparatus according to the second embodiment of the present invention. In addition, in radio apparatus 200 in FIG.3, structural sections common to radio apparatus 100 in FIG.2 are assigned the same reference numerals as in FIG.2 to omit the explanation thereof.

[0037] A feature of the second embodiment is that the radio apparatus is provided with two reception systems to enable itself to concurrently receive signals with different frequencies.

[0038] Radio apparatus 200 illustrated in FIG.3 has, in addition to the configuration of radio apparatus 100 in FIG.2, antenna 201, band-pass filter 202, low noise amplifier 203, band-pass filter 204, down-mixer 205, band-pass filter 206, gain control amplifier 207, quadrature demodulator 208, low-pass filters 209 and 210, and A/D converters 211 and 212. Then, in radio apparatus 200, down-mixer 205 is connected to switch 127, and

down-mixer 115 is connected to transmission RF frequency synthesizer 124.

[0039] In the ordinary communication in which $fr - ft$ is constant, switch 127 connects transmission RF frequency synthesizer 124 and down-mixer 205 corresponding to the control signal B, and reception RF frequency synthesizer 125 is turned off with the control signal A.

[0040] In this case, a quadrature modulated signal received at antenna 201 is filtered in band-pass filter 202 to pass a signal with a predetermined frequency band, subjected to low noise amplification in low noise amplifier 203, filtered in band-pass filter 204 to pass a signal with a predetermined frequency band, and then converted in down-mixer 205 into a signal with the reception IF frequency f_4 ($f_4 = f_2 - fr$) using a signal with the frequency f_2 generated in transmission RF frequency synthesizer 124.

[0041] The converted signal with the reception IF frequency f_4 is filtered in band-pass filter 206 to pass a signal with a predetermined frequency band, amplified in gain control amplifier 207 corresponding to a control voltage, subjected to quadrature demodulation in quadrature demodulator 208 using a signal with the frequency f_4 generated in reception IF frequency synthesizer 126, and thereby modulated to a second I signal and second Q signal.

[0042] The converted second I and Q signals are subjected to low-pass filtering in low-pass filters 209 and 210, and converted into respective digital signals in A/D converters 211 and 212, respectively, whereby second I data and second Q data is output.

[0043] Since it is thereby possible for down-mixer 115 and down-mixer 205 to use the same frequency as the reception RF frequency of which a signal is multiplied in each mixer, two reception systems can receive signals with the same frequencies, and thereby can perform reception diversity.

[0044] The explanation is next given of the operation of local section 138 when the apparatus receives a signal with the reception frequency fr' that is different from a frequency in the ordinary communication, while transmitting a signal with the transmission RF frequency ft .

[0045] Transmission RF frequency synthesizer 124 in Local section 138 outputs a signal with the transmission RF frequency ft such that $fr - ft$ is constant using a signal with the frequency f_2 .

[0046] Down-mixer 115 multiplies an output signal from band-pass filter 114 by a signal with the frequency f_2 generated in transmission RF frequency synthesizer 124. in the same way as the operation in the ordinary communication in which $fr - ft$ is constant.

[0047] Reception RF frequency synthesizer 125 is turned on with the control signal A, and generates a signal with the frequency f_3 such that $f_3 - fr'$ equals f_4 ($f_4 = f_3 - fr'$). Switch 127 is controlled with the control signal B in synchronism with a timing at which a reception

is started so as to connect reception RF frequency synthesizer 125 and down-mixer 205.

[0048] Down-mixer 205 multiplies an output signal from band-pass filter 204 by a signal with the frequency f_4 generated in reception RF frequency synthesizer 125.

[0049] Thus, a plurality of reception systems is provided and one of the reception systems is configured in the same way as in the first embodiment, whereby it is possible to improve reception characteristics by performing diversity reception at the time of the ordinary communication, and further to decrease the current consumption.

[0050] In addition, it may be possible to connect down-mixer 115 to switch 127 in the same way as in the first embodiment and further connect down-mixer 205 to transmission RF frequency synthesizer 124, which is capable of operating in the same way as in the above configuration.

(Third embodiment)

[0051] A feature of the third embodiment is to enable two reception systems to concurrently receive signals with frequencies different from the frequency in the ordinary communication.

[0052] FIG.4 is a block diagram illustrating a configuration of a radio apparatus according to the third embodiment of the present invention. In addition, in radio apparatus 300 in FIG.4, structural sections common to radio apparatus 200 in FIG.3 are assigned the same reference numerals as in FIG.3 to omit the explanation thereof.

[0053] Radio apparatus 300 illustrated in FIG.4 has switch 301 of which the switching is controlled with the control signal B, in addition to the configuration of radio apparatus 200 in FIG.3, where down-mixer 115 is connected to switch 127, and down-mixer 205 is connected to switch 301.

[0054] In such a configuration, the operation in radio apparatus 300 at the time of the ordinary communication where $fr - ft$ is constant is the same as that in radio apparatus 200 explained in the second embodiment.

[0055] The explanation is next given of the operation of local section 138 when the apparatus receives a signal with the reception frequency fr' that is different from a frequency in the ordinary communication, while transmitting a signal with the transmission RF frequency ft .

[0056] Transmission RF frequency synthesizer 124 in Local section 138 outputs a signal with the transmission RF frequency ft such that $fr - ft$ is constant using a signal with the frequency f_2 .

[0057] Reception RF frequency synthesizer 125 is turned on with the control signal A, and generates a signal with the frequency f_3 such that $f_3 - fr'$ equals f_4 ($f_4 = f_3 - fr'$). Then, with the control signal B in synchronism with a timing at which a reception

nism with a timing at which a reception is started, switch 127 is controlled to connect reception RF frequency synthesizer 125 and down-mixer 115, and switch 301 is controlled to connect reception RF frequency synthesizer 125 and down-mixer 205.

[0058] Down-mixer 115 multiplies an output signal from band-pass filter 114 by a signal with the frequency f_4 generated in reception RF frequency synthesizer 125, and down-mixer 205 multiplies an output signal from band-pass filter 204 by the signal with the frequency f_4 generated in reception RF frequency synthesizer 125.

[0059] Thus, a plurality of reception systems is provided and all of the reception systems are configured in the same way as in the first embodiment, whereby it is possible to improve reception characteristics by performing diversity reception also at the time of receiving a signal with a frequency different from that in the ordinary communication besides at the time of the ordinary communication.

(Fourth embodiment)

[0060] FIG.5 is a block diagram illustrating a configuration of a radio apparatus according to the fourth embodiment of the present invention. In addition, in radio apparatus 400 illustrated in FIG.5, structural sections common to radio apparatus 100 in FIG.2 are assigned the same reference numerals as in FIG.2 to omit the explanation thereof. Radio apparatus 400 illustrated in FIG.4 has symbol inverting circuit 402 in addition to the configuration of radio apparatus 100 in FIG.1. [0061] The operation of radio apparatus 400 at the time of the ordinary communication where f_r minus f_t is constant is the same as that in radio apparatus 100 except that symbol inverting circuit 401 is set to its non-inverting state with the control signal B.

[0062] The explanation is next given of the operation of local section 138 when the apparatus receives a signal with the reception frequency f_r' such that f_r minus f_t is not constant, while transmitting a signal with the transmission RF frequency f_t .

[0063] Transmission RF frequency synthesizer 124 in Local section 138 outputs a signal with the transmission RF frequency f_t such that f_r minus f_t is constant using a signal with the frequency f_2 .

[0064] Reception RF frequency synthesizer 125 is turned on with the control signal A, and generates a signal with the frequency f_3 such that f_3 minus f_r' equals f_4 ($f_4 = f_3 - f_r'$). Switch 127 is controlled with the control signal B in synchronism with a timing at which a reception is started to connect reception RF frequency synthesizer 125 and down-mixer 115.

[0065] Down-mixer 115 multiplies an output signal from band-pass filter 114 by a signal with the frequency f_4 generated in reception RF frequency synthesizer 125.

[0066] At this point, symbol inverting circuit 401 is

set to its inverting state with the control signal B.

[0067] Thus, since symbol inverting circuit 401 is provided in addition to the configuration of the first embodiment, it is possible to adopt a large frequency difference between the frequency f_2 of transmission RF frequency synthesizer 124 and the frequency f_3 of reception RF frequency synthesizer 125. Therefore, in addition to obtaining the same effect as in the first embodiment, it is possible to reduce the intermodulation between the f_2 and f_3 when the frequency synthesizers 124 and 125 concurrently operate.

[0068] In addition, the fourth embodiment may be combined with any of the second embodiment and third embodiment.

[0069] That is, as radio apparatus 500 in FIG.6, the configuration of radio apparatus 400 in FIG.5 is given antenna 201, band-pass filter 202, low noise amplifier 203, band-pass filter 204, down-mixer 205, band-pass filter 206, gain control amplifier 207, quadrature demodulator 208, low-pass filters 209 and 210, A/D converters 211 and 212, and symbol inverting circuit 402. Then, in radio apparatus 500, down-mixer 205 is connected to switch 127, and down-mixer 115 is connected to transmission RF frequency synthesizer 124. It is thereby possible for two reception systems to receive signals with the same frequencies to perform antenna diversity.

[0070] Further, as radio apparatus 600 in FIG.7, it may be possible to add switch 301 of which the switching is controlled with the control signal B to the configuration of radio apparatus 500 in FIG.6, connect down-mixer 115 to switch 127, and further connect down-mixer 205 to switch 301. It is thereby possible to improve reception characteristics by performing diversity reception also at the time of receiving a signal with a frequency different from that in the ordinary communication besides at the time of the ordinary communication.

[0071] As explained above, according to the radio apparatus and transmission and reception method of the present invention, it is possible to switch frequencies fast and with low current consumption in receiving a signal with a reception frequency other than a

Claims

1. A radio apparatus comprising a function of combining a first frequency signal generated in a common frequency synthesizer with a quadrature modulated I signal and a quadrature modulated Q signal, while combining the first frequency signal with a received signal at a time of an ordinary communication, and combining, at another time of receiving a signal with a frequency different from that of the first frequency signal, a received signal with a second frequency signal, generated in a reception frequency synthesizer, with the frequency different from that of the first frequency signal.

2. A radio apparatus comprising:

a common frequency synthesizer that generates a first frequency signal with a frequency comprised of a combination of a transmission frequency and a reception frequency; 5
 a reception frequency synthesizer that generates a second frequency signal with a frequency different from that of the first frequency signal, and operates only in receiving a signal with a frequency different from that of the first frequency signal; 10
 a transmission mixer that combines the first frequency signal with a quadrature modulated I signal and a quadrature modulated Q signal each for transmission; 15
 a reception mixer that combines a received signal with the first frequency signal or the second frequency signal; and
 a switch that connects said common frequency synthesizer and said reception mixer, while connecting said reception frequency synthesizer and said reception mixer only in receiving the signal with the frequency different from that of the first frequency signal. 20

3. The radio apparatus according to claim 2, wherein said apparatus comprises another reception circuit having a second reception mixer that combines the first frequency signal with another received signal at another antenna to perform diversity reception. 25

4. The radio apparatus according to claim 3, further comprising:

a second switch that connects the common frequency synthesizer and the second reception mixer, while connecting the reception frequency synthesizer and the second reception mixer only in receiving the signal with the frequency different from that of the first frequency signal. 30

5. The radio apparatus according to claim 2, further comprising:

first symbol inverting means for inverting a symbol of I data obtained by subjecting a signal combined in the reception mixer to quadrature demodulation and then to A/D conversion; and second symbol inverting means for inverting a symbol of Q data obtained by subjecting a signal combined in the reception mixer to quadrature demodulation and then to A/D conversion. 35

6. The radio apparatus according to claim 3, further comprising:

third symbol inverting means for inverting a symbol of I data obtained by subjecting a signal combined in the second reception mixer to quadrature demodulation and then to A/D conversion; and

fourth symbol inverting means for inverting a symbol of Q data obtained by subjecting a signal combined in the second reception mixer to quadrature demodulation and then to A/D conversion. 40

7. The radio apparatus according to claim 4, further comprising:

first symbol inverting means for inverting a symbol of I data obtained by subjecting a signal combined in the reception mixer to quadrature demodulation and then to A/D conversion; second symbol inverting means for inverting a symbol of Q data obtained by subjecting a signal combined in the reception mixer to quadrature demodulation and then to A/D conversion; third symbol inverting means for inverting a symbol of I data obtained by subjecting a signal combined in the second reception mixer to quadrature demodulation and then to A/D conversion; and

fourth symbol inverting means for inverting a symbol of Q data obtained by subjecting a signal combined in the second reception mixer to quadrature demodulation and then to A/D conversion. 45

8. A communication terminal apparatus having a radio apparatus, said radio apparatus comprising:

a common frequency synthesizer that generates a first frequency signal with a frequency comprised of a combination of a transmission frequency and a reception frequency; a reception frequency synthesizer that generates a second frequency signal with a frequency different from that of the first frequency signal, and operates only in receiving a signal with a frequency different from that of the first frequency signal; 50

a transmission mixer that combines the first frequency signal with a quadrature modulated I signal and a quadrature modulated Q signal each for transmission;

a reception mixer that combines a received signal with the first frequency signal or the second frequency signal; and

a switch that connects said common frequency synthesizer and said reception mixer, while connecting said reception frequency synthesizer and said reception mixer only in receiving the signal with the frequency different from that

of the first frequency signal.

9. A transmission/reception method, wherein at a time of ordinary reception, a transmission mixer combines a first frequency signal with a quadrature modulated I signal and a quadrature modulated Q signal, said first frequency signal being generated in a common frequency synthesizer and having a frequency comprised of a combination of a transmission frequency and a reception frequency, and a reception mixer combines the first frequency signal with a received signal, while at a time of receiving a signal with a frequency different from that of the first frequency signal, a transmission mixer is operated to generate a second frequency signal with a frequency different from that of the first frequency signal, and said reception mixer combines the second frequency signal with a received signal.

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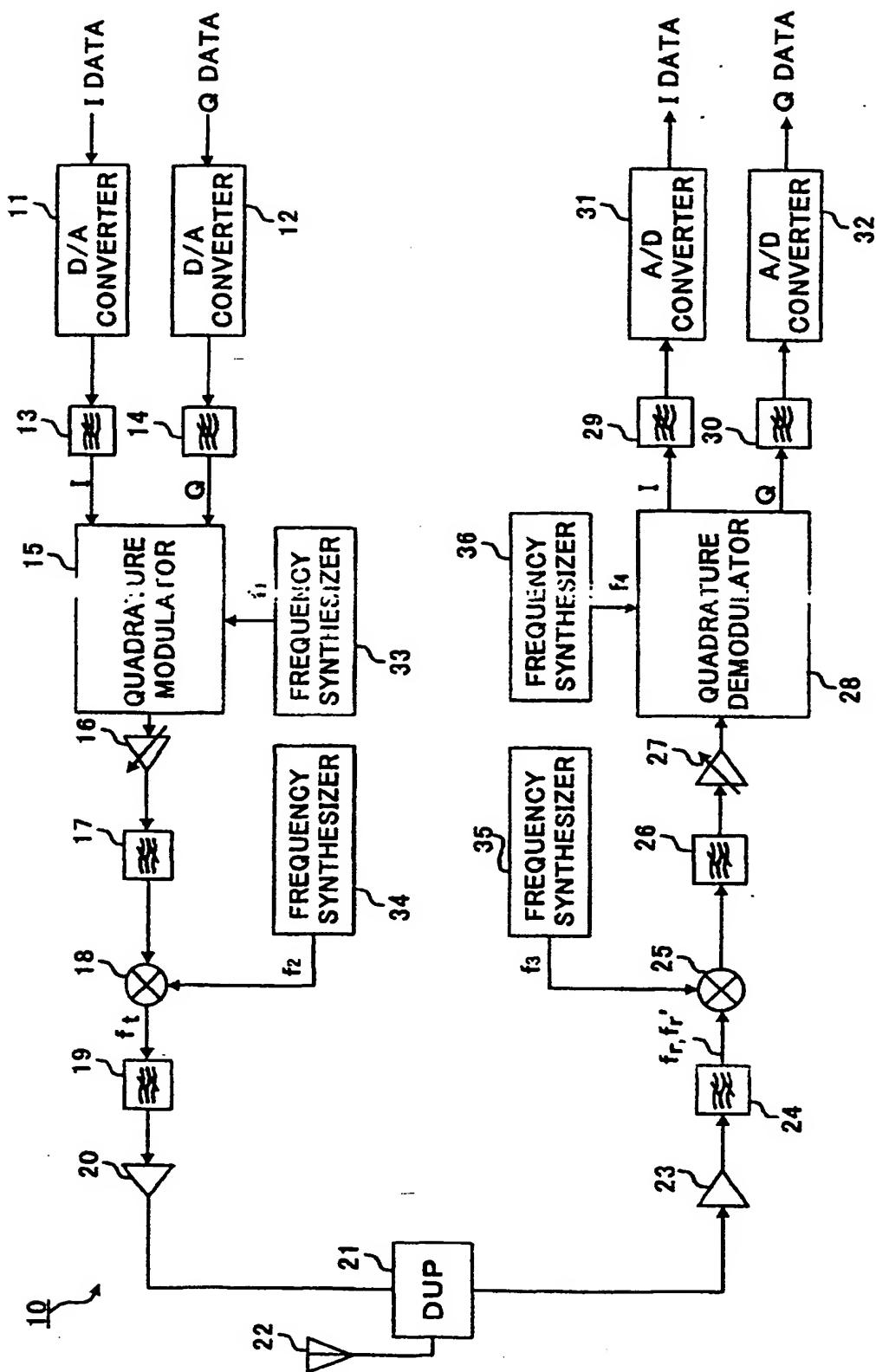


FIG.1

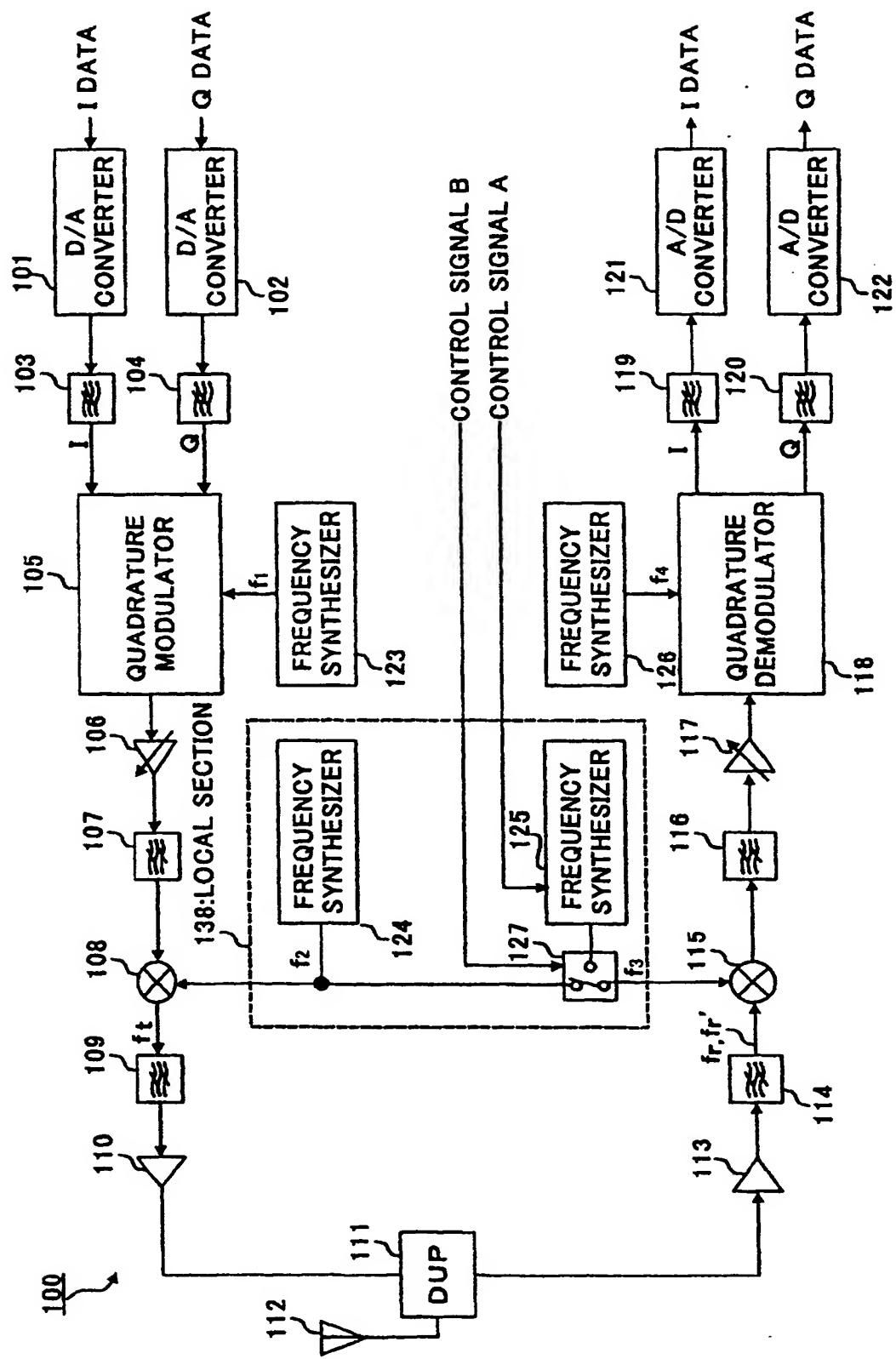


FIG.2

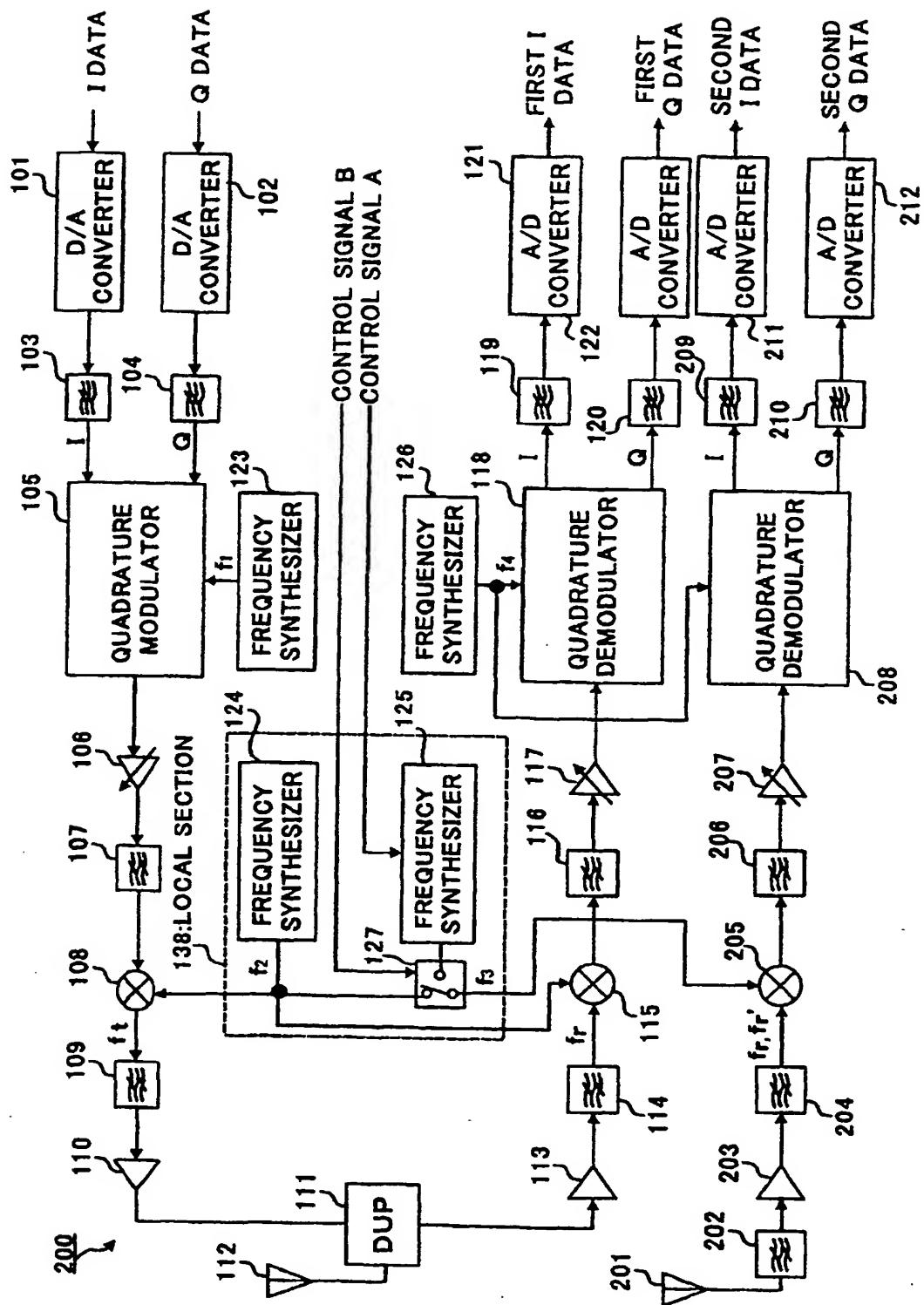


FIG.3

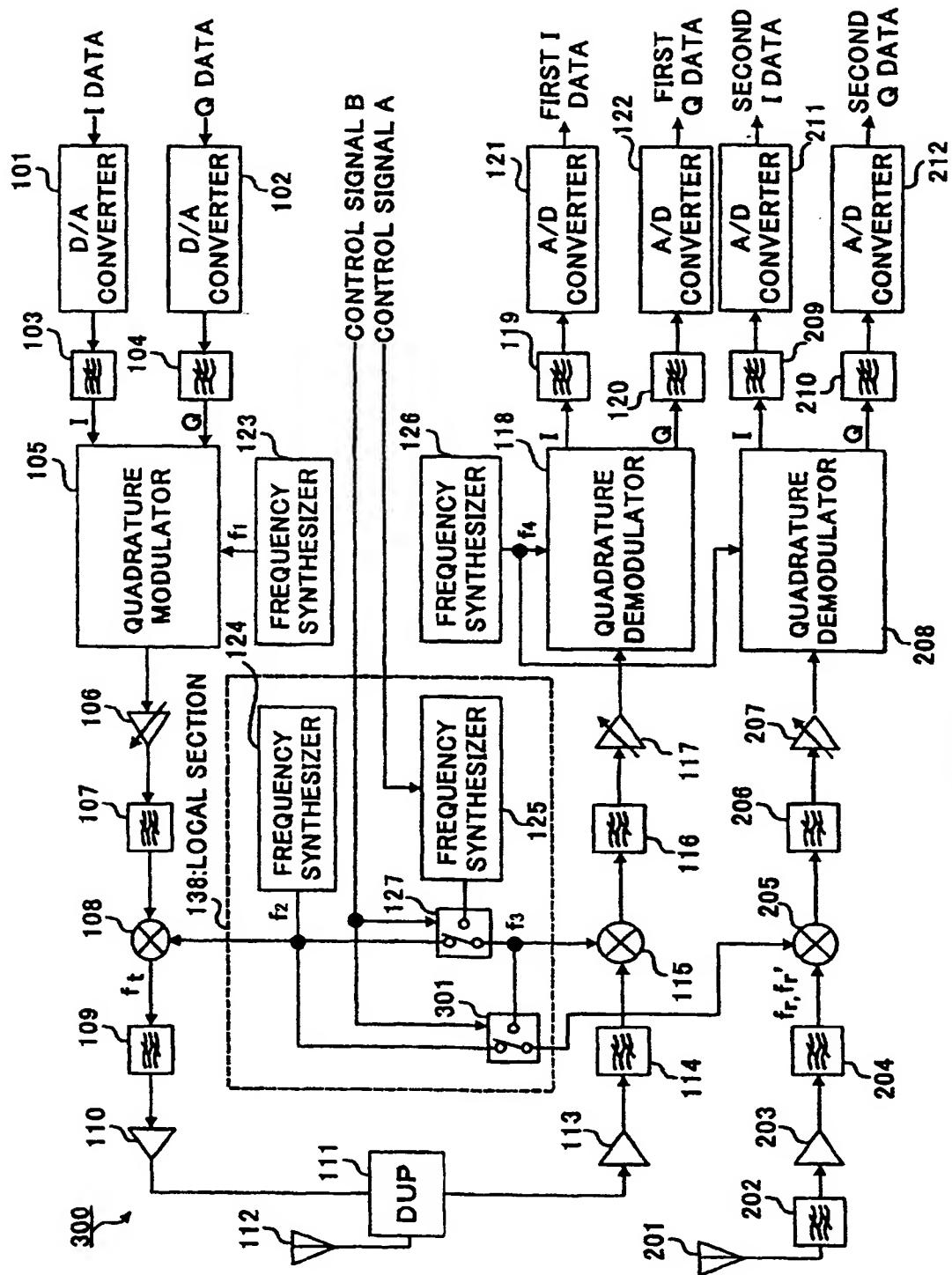


FIG.4

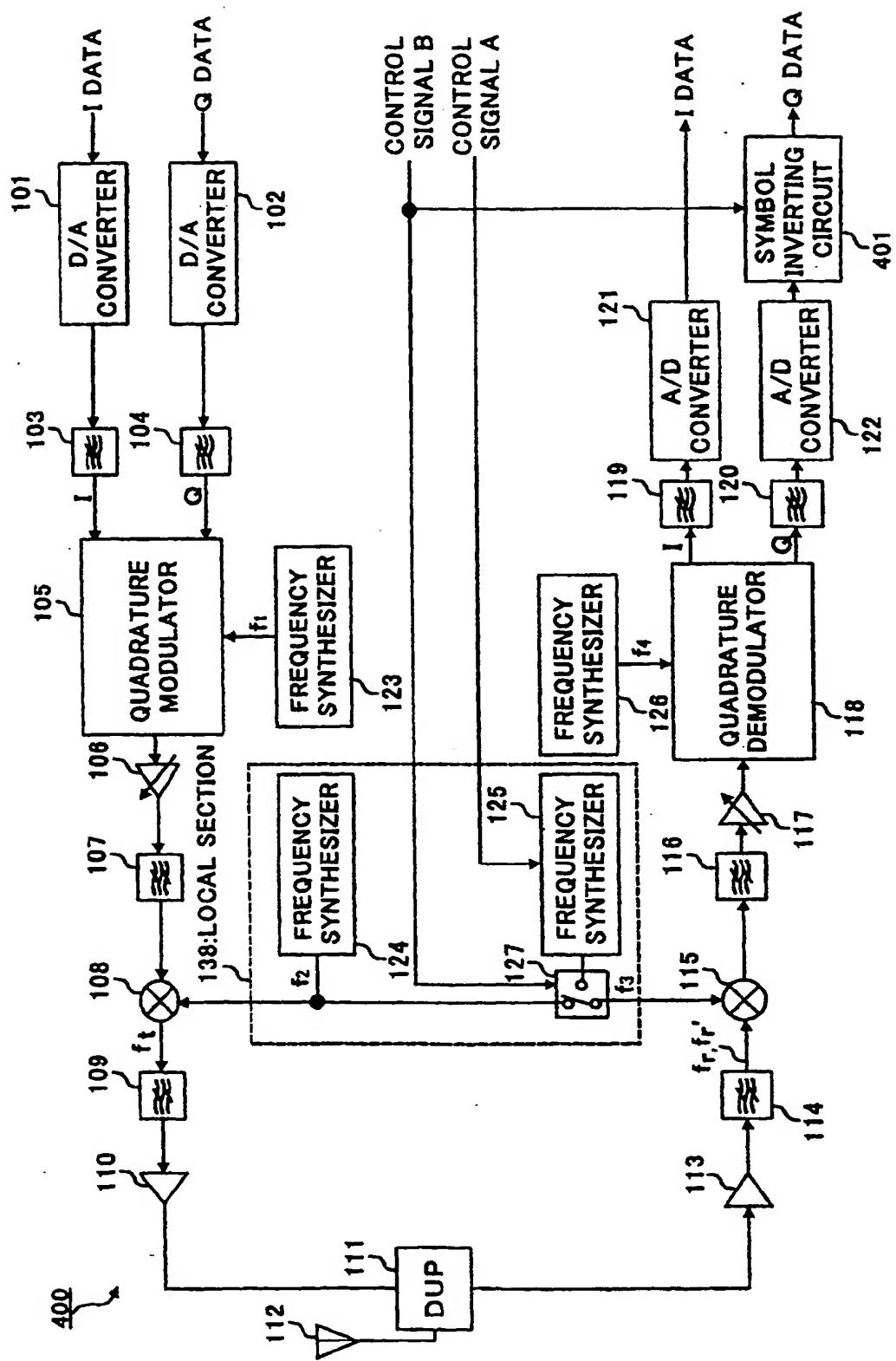
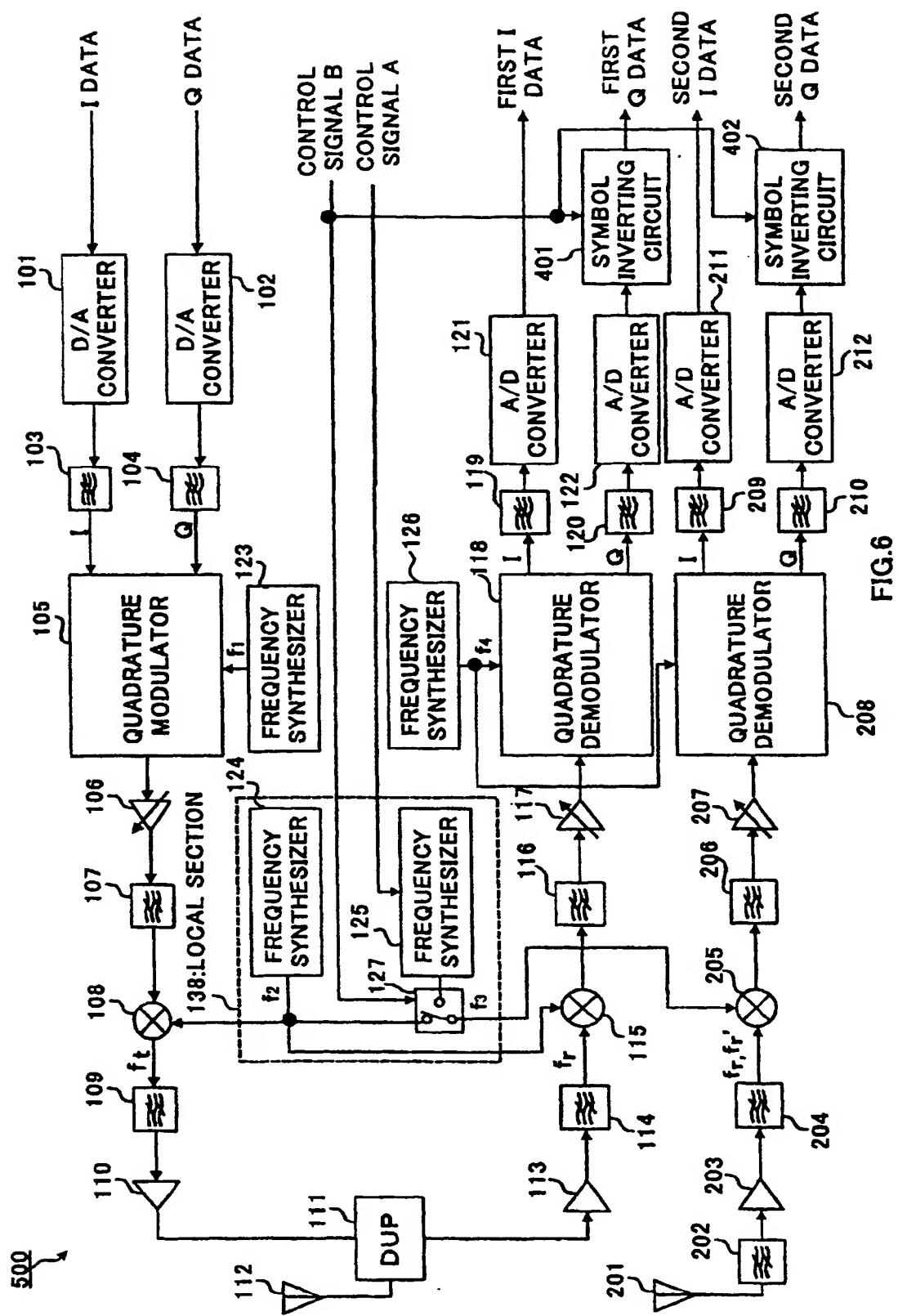


FIG. 5



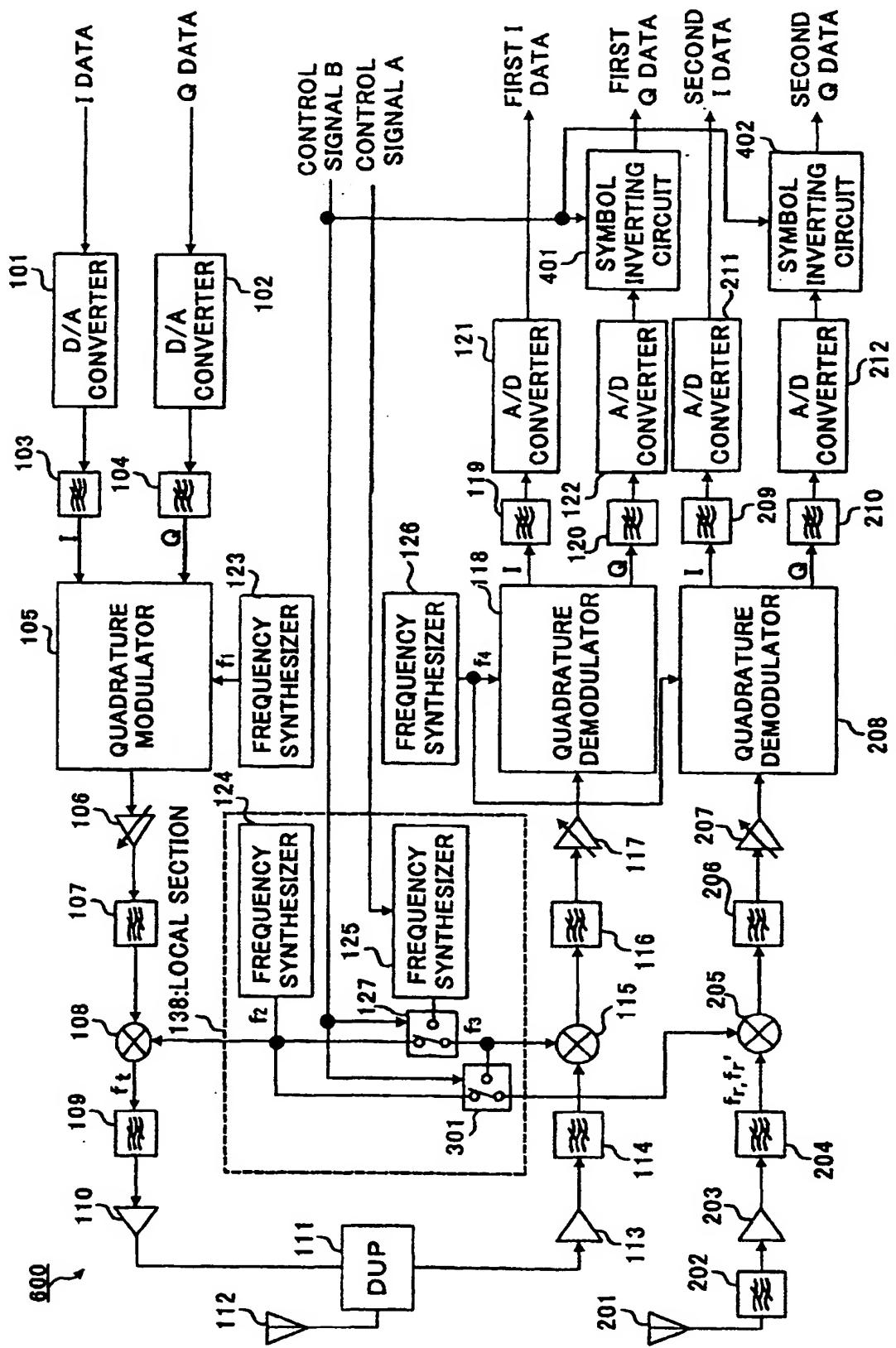


FIG.7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP00/01910

A. CLASSIFICATION OF SUBJECT MATTER
Int.C1' H04B1/38, H04B7/26

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.C1' H04B1/38, H04B7/26Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-2000 Toroku Jitsuyo Shinan Koho 1994-2000
Kokai Jitsuyo Shinan Koho 1971-2000 Jitsuyo Shinan Toroku Koho 1996-2000

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP, 4-21220, A (Sony Corporation), 24 January, 1992 (24.01.92), Implementation example; Fig. 1 (Family: none)	1, 2, 8, 9
Y	JP, 10-322407, A (Matsushita Electric Ind. Co., Ltd.), 04 December, 1998 (04.12.98), [Prior Art]; Fig. 1 & EP, 878916, A2 & CN, 1201304, A	1, 2, 8, 9

 Further documents are listed in the continuation of Box C. See patent family annex.

- * Special categories of cited documents:
- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
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- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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- "&" document member of the same patent family

Date of the actual completion of the international search 18 April, 2000 (18.04.00)	Date of mailing of the international search report 02 May, 2000 (02.05.00)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer

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